twenty years old, had all the sieve-tubes at its base still in a state of full activity. In a stem of *Yucca aloifolia*, about fifteen years old, the sieve-tubes of all the fibro-vascular bundles, even the innermost, were active, and had their sieves covered with callus; but this was no thicker in the oldest than in the youngest tubes. In a stem of *Dracæna draco*, at least twenty years old, the callus had nearly or entirely disappeared from many of the sieve-tubes; but the plant was otherwise in bad health.

The callus is not a reserve-substance; for in gymnosperms and dicotyledons it often remains unchanged for years in the dead sieve-tubes, and even in leaves which have fallen in the autumn, and in aërial branches which die in the winter. It behaves rather like a secretory product; and this view is confirmed by the study of its development. The organised structure which the callus sometimes exhibits is not a sufficient objection to this view.

Under which class of organic compounds the callus should be placed cannot at present be determined with certainty. Its behaviour to iodine-reagents and to aniline blue appears to indicate an alliance with proteinaceous substances, and especially with nuclein; in this respect it differs altogether from the solid carbohydrates, such as cellulose and starch.

All sieve-tubes resemble one another in their contents, at least as far as relates to the parietal protoplasm and water. The mucilage, which is undoubtedly a non-granular protoplasm, only exists in large quantities in dicotyledons; no mucilaginous threads can be detected in monocotyledons or vascular cryptogams; in some monocotyledons there is simply an accumulation of mucilage in the sieve-tubes. The sieve-tubes of these two classes contain, on the other hand, a large quantity of smaller or larger refringent globules, which are also proteinaceous. Similar globules have been observed in the closed vascular bundles of *Hippuris vulgaris*.

Although starch is almost always present in the sieve-tubes of open vascular bundles, it is seldom to be met with in those of closed bundles. The diameter of the starch-grains is always greater than that of the canals which are clothed with callus, which renders it impossible for them to pass from cell to cell as long as the sieve-tubes are in an active state. The reddish-violet or brick-red colour which these starch-grains take with iodine reagents indicates the presence of a diastase among the contents of the sieve-tubes.

A series of observations on the same organs by E. Janczewski (*Ann. Sci. Nat.* xiv. 1882, Parts 1 and 2) was directed mainly to a comparison of their structure in the different primary groups of the vegetable kingdom.

In vascular cryptogams the elements of the sieve-tubes are not much larger than those of the parenchymatous tissue. They have no nucleus, and contain proteinaceous globules, adhering to the parietal protoplasm, and collected below the pores. Both the lateral and terminal walls have a larger or smaller number of pores. The membrane of these pores is never perforated, and prevents the intercommunication of the contents of adjoining elements; it is sometimes (as in *Pteris aquilina*) pierced by callose cylinders. The time of year exercises no influence on the sieve-tubes, which remain in the same condition through the whole of their existence.

In gymnosperms the life of the sieve-tubes may be divided into two periods, *evolutive* and *passive*. During the first period the pores in the walls of the young tube produce callose substance, and are transformed into sieves covered and closed by the callus; the elements of the tubes contain, at this period, parietal protoplasm. During the second period the tubes entirely lose their protoplasm, and become inert; but at its very commencement the sieves also lose their callus, and free communication is established between adjacent elements.

In dicotyledons the structure of the tubes is still more complicated; their life may be divided into four periods: *evolutive*, *active*, *transitional*, and *passive*. During the first period the cambial cell is not transformed immediately into an element of the tube, as in gymnosperms; it divides longitudinally, and produces on one side an element of the tubes, on the other side one or two cells of the liber-parenchyma. In the elements thus separated, the pores of the walls, or the entire horizontal septa, become covered with callus, and perforated into true sieves composed of a delicate network of cellulose and a callose envelope. The tubes now enter the second or active period, characterised by the sieve-structure and the free intercommunication of the protoplasmic contents of adjacent elements. It may last for months or years. In some cases the sieves are closed before winter by a fresh formation of callus, and open again in the spring. During this period the tubes contain protoplasm, a larger or smaller quantity of a mucilaginous proteinaceous substance, and sometimes starch. During the transitional period the tubes gradually lose their contents; the sieves are closed by callus, and reopen again by the complete absorption of the callose substance. They have now entered the passive period; they are completely inert, and contain no organic matter; the sieves are reduced to a delicate network of cellulose.

The development and behaviour of the sieve-tubes of monocotyledons resemble that of dicotyledons, and their life may be divided into the same four periods. But from the fact of the vascular bundles being closed, and having no cambial zone capable of forming fresh tubes, the active period of the tubes may last as long as the life of the organ which contains them requires it. The passive period is, in fact, rarely manifested. In our climate the sieve-tubes have the power of closing their sieves in autumn, and reopening them in spring. The elements of the tubes contain no starch or mucilaginous substance; and their parietal protoplasm only contains proteinaceous particles which seem to disappear in the spring, and to add to the density and refrangibility of the protoplasm.

CASSELL'S NATURAL HISTORY[1]

With the sixth volume, this well-illustrated account of the natural history of the animal kingdom is brought to a close, and the six handsome volumes leave nothing to be desired, so far as good covers inclosing excellent paper and beautiful typography are concerned. Indeed, the general get-up of the series is quite unexceptional, and as to the average value of the scientific contents we feel fully justified, on the strength of such contributors as Parker, Sharpe, Carpenter, Dallas, Sollas, &c., in strongly recommending the series to the majority of our readers.

From a purely scientific point of view, we regret the title selected by the Editor. He should not have launched so important a book in these days upon the sea of science under an obviously wrong title. The "Historia naturalis" embraces, as the Professor of Geology in King's College, London, well knows, something more than an account of the members of one of nature's kingdoms, and of their distribution in space and time. It is therefore certainly not scientific, and we take it as against modern culture to adhere to such a style. If, indeed, the eminent firm of publishers were to extend this natural history so that in another half-dozen volumes we should have an account of the equally interesting, and even more important vegetable kingdom, the title of the series would the more approach exactness.

Although in the title of his work the Editor has followed in the footsteps of the mere compiler, he has by no means

[1] "Cassell's Natural History." Edited by P. Martin Duncan, M.D. Lond., F.R.S., Professor of Geology, King's College, London. Volumes 1 to 6, illustrated. Volume 6. (London, Paris, and New York: Cassell, Petter, Galpin, and Co., 1883.)

followed this example in the direction of writing on all the groups of the animal kingdom with his own pen, but has been fortunate in getting together a number of contributors, whose very names command respect for their contributions. The table of contents of the just published volume shows that the subjects of the Insects, Myriopods, and Arachnids have been written by Mr. W. S. Dallas, with the exception of the Lepidopterous Insects written about by Mr. W. F. Kirby, the Crustacea are described by Mr. Henry Woodward, the Echinoderms by Mr. Herbert Carpenter, the Sponges by Prof. Sollas, the Rhizopods by Prof. Rupert Jones, and the Worms, Zoophytes, and Infusoria by the Editor.

We have been greatly struck by the immense amount of information given to us by Mr. Kirby in Chapter IX., which treats of the characteristics of the order of Lepidoptera, gives an account of the evolution of these insects from the egg to the perfect state; describes the imago condition; gives a condensed but very clear account of their anatomy, food, and geographical distribution, and concludes with a few hints on collecting, killing, and setting. Among the statistics of lepidopterous life, we note that the present census gives about 10,000 species of butterflies, and 40,000 moths; but then Mr. Kirby adds: "Hundreds of new species are being added to our lists every year." The abundance of species in a district would seem to be in proportion to the variety of the vegetation, which latter is intimately connected with variety of elevation, and so it is "that Lepidoptera are far more numerous in Switzerland than in the peninsulas of Italy and Spain:" but is it not possible that the mountainous regions of Spain will still yield many as yet unknown forms? The illustrations in this portion of the volume are often very beautiful, and comparatively new. Of the next order, Diptera, says Mr. Dallas, "it is not easy to arrive at any trustworthy estimate of the total number of species, yet allowing Dr. Schiner's estimate of 9000 species as European, it has been calculated that the total fly population of the world would be from 150,000 to 160,000. Only a very few of this great army could be of course alluded to, but the information given about the gnats, midgets and crane flies is very full and interesting. Many of these forms are injurious to our crops, as well as irritating to ourselves. The Gall Midges (Cecidomyidæ) are among the most delicate species of all these gnat-like Diptera. The larvæ of these elegant little insects feed

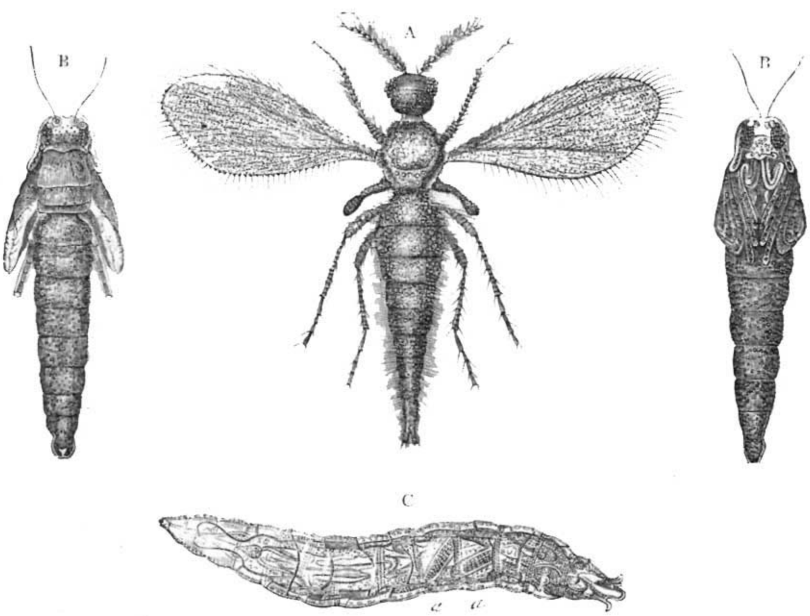

Fig. 1.—Cecidomyid with viviparous larva. A, adult insect; B, B, pupæ; C, larva, showing young larvæ at *a a*.

upon various species of plants. The number of species is very considerable, about 100 being recorded as European. Many of them by attacking useful plants, frequently do much mischief. Among these may be mentioned the Hessian Fly (*Cecidomyia destructor*), which has done so much damage to the grain crops of the United States, and which received its name from a belief that it was introduced into the States with the baggage brought by the Hessian troops in the pay of the British Government about the year 1776. The Wheat Midge (*C. tritici*) is an enemy of the wheat crops in this country, sometimes doing much damage; several other species form the flower-like galls oftentimes found on willows.

In 1860 Dr. Nicolas Wagner, of Kasan, made the startling discovery that in certain of these Cecidomyids the larval stages could give rise by a kind of budding, to several small larval-like forms, and that when these latter got free, they in their turn produced still other larval forms in the same curious fashion, and so one generation succeeds another throughout the autumn, winter, and spring. In the summer the last generation undergoes a change to the pupa state, and from these pupæ the perfect winged males and females emerge. The latter lay eggs in the bark of trees, and the larvæ produced from these commence once more a fresh series of organic broods. This strange circle of development is in part represented in the accompanying illustration, which will serve as a fair example of those which abound in this volume. All the families of the flies, ending with that of the flea, which, however, is placed in an order by itself, are well and judiciously treated.

The chapter on the Rynchota is also, despite its subject, a very interesting one, and a great deal of useful information is crowded into a small space. Mentioning the noise produced by the male Cicadæ, the author says: "During the heat of the day they sit concealed amongst the foliage of the trees and shrubs, and sing incessantly;" but is it not rather their wont to select the end of some dead twig, or the extremity of some vine pole, and there out in the full glare vibrate violently. A little space might have been spared for an account or figure of the vine phylloxera.

The chapter on the Orthoptera begins with the crickets and ends with the springtails. Among the Myriopods

we find the orders Pauropoda and Onychophora, the latter for Lansdowne Guilding genus Peripatus, which, by the way, he referred in his original description to the mollusca, and not, as here stated, to the worms.

The chapter on the Arachnida includes the Scorpions and their allies the Spiders, Mites, Tardigrades, and Pantopods; in the sketch of the latter a half page might usefully have been devoted to recent researches on the distribution of this extraordinary group of marine forms in the depths of the sea.

The class of Crustacea is well illustrated, and in the

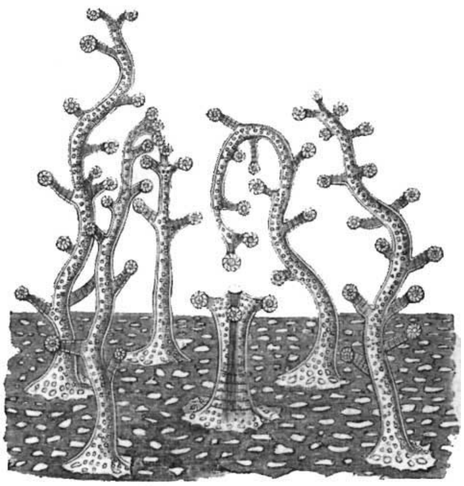

Fig. 2.—Millepora, showing expanded zooids.

introductory chapter we have an excellent account of the general anatomy and strange development of the group. Even Fritz Müller's account of the metamorphosis of Penæus is given, with figures of the Nauplius, Zoea, and Mysis stages. The typographical arrangements of the headings of the orders of the Crustacea seem faulty. The Editor's eye has failed him here, and though the sense is in no ways altered by the want of uniformity in the type used for the headings Brachyura (p. 197), Anomoura (p. 202), Macroura (204), yet there is a utility in the case of a classification of appealing to the eye. The

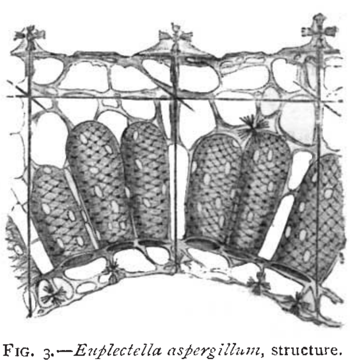

Fig. 3.—*Euplectella aspergillum*, structure.

King Crabs are placed as usual among the Crustacea, but the joint authors (Messrs. Dallas and Woodward), in their concluding remarks on the Arthropods write: "the structural relations of these to the scorpions would seem to be very close, and certainly raise a difficult problem, one which is rendered still more interesting by the fact that, according to the researches of Dr. Jules Barrois, a Limuloid, or King Crab-like stage occurs in the development within the egg of certain true spiders. For the present, this and many other such questions must, however, remain open. In all biological problems relating to the past developmental history of the organic world, we must for a long time yet expect to come continually upon obscure and puzzling points which only a more extended knowledge of minute details can clear up."

The various classes of the "grand division" of the worms are treated rather unevenly. This grand division is, no doubt, a somewhat heterogeneous one. "Thus it is found that an animal does not exactly correspond with one of the articulate groups, and another resembles in certain points, but not in all, an Infusorian. They are then placed with the Vermes [worms] because of the existence of certain fundamental structures." There is a good deal of minute anatomical detail given about the Leeches and Rotifers, while the Land Planarians are dismissed with the following:—"They have eyes, no tentacles, a proboscis, and a narrow body. They are found in the United Kingdom and generally in Western

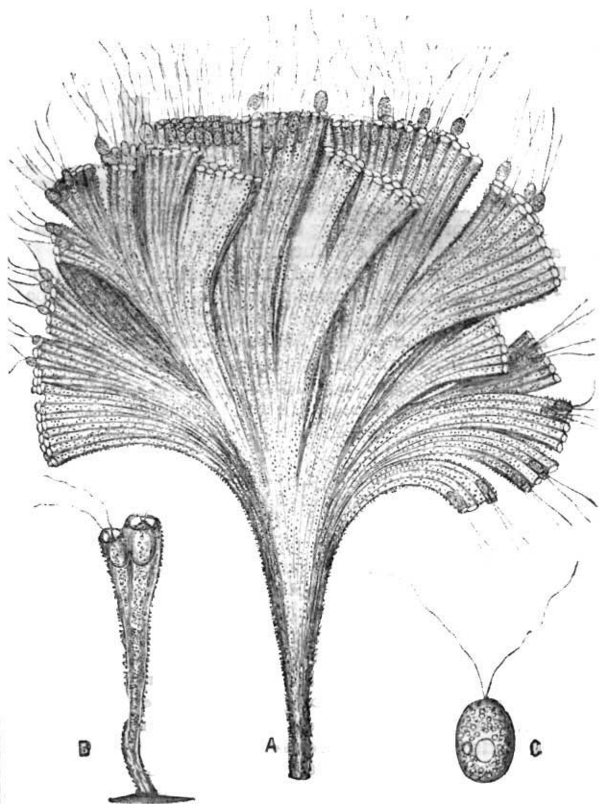

Fig. 4.—*Rhipidodendron splendidum.* A, colony; B, two monads; C, free monad.

and Central Europe. They have been found in America and on continental as well as on oceanic islands. Moseley says that they are nocturnal in their habits, when in the light getting under leaves. Some contain chlorophyll and seek the light, but die in the sunshine. They eat small snails, worms, and flies. An American kind secretes a mucous thread, and suspends itself in the water, and another lets itself down from the leaves by one."

If we were introduced to the Worms as a Grand Division, we are told that the Echinoderms form a Sub-Kingdom of the Animal Kingdom, but there is nothing to guide us to this in the heading of the portion of this volume in which Mr. Herbert Carpenter so well, though succinctly describes this important group, an account that we would have wished to have been much more detailed. The classes of this group getting about three pages of text to each, and several of the pages are devoted to new and excellent woodcuts.

The group of the Zoophyta embraces the Hydrozoa and

Actinozoa. These "are distinct from the Spongida, although some synthetic-minded morphologists classify all together as Cœlenterata." In treating of the freshwater Hydra we notice the "old story" repeated that "if the body be turned inside out, the old ectoderm [why the adjective?] takes on the digestive power and the former endoderm that [takes on the function] of the skin."

The order Hydrocorallina is placed as the last of the Hydrozoa, with the families Milleporidæ and Stylasteridæ, as indicated by Moseley, to whose researches and those of Agassiz we are indebted for all we know about the order. *Millepora alcicornis* was obtained by Moseley at Bermuda. The calcareous tissue of the coral is very hard and compact, and the polyps are extremely small. It is very difficult to prevail on the polyps to protrude themselves from their cells, but Mr. J. Murray, of the *Challenger* Expedition, succeeded in procuring them in this state on two occasions, and the accompanying drawing (Fig. 2) of one of the expanded polyps, and of five of its surrounding zooids, is from Mr. Moseley's memoir on the structure of this genus. In the centre is seen the short polyp form provided with a mouth and with only four short knobby tentacles, while grouped around are the five polyps without mouths, and for the sake of letting the central zooid be clearly seen a sixth mouthless zooid is omitted from the sketch; these latter zooids have from five to twenty tentacles; they are much more active than the mouth-bearer, and do the work of catching food for it. When alarmed all disappear within the framework.

The article on the group of the Sponges is excellent. The author now regards the sponges as forming a separate class independent of the Cœlenterata, and situated at the very bottom of the Metazoic sub-kingdom, and gives a brief sketch of the orders and sub-orders.

The figures of sponge structure are refreshingly new, many of them being from quite recent sources—such as the memoirs of Haeckel, Schulze, and Prof. Sollas himself. The beautiful sponge belonging to the genus Euplectella, now known to live anchored in the mud in deep seas, or attached to the hard bottoms of shallower waters, has had its structure ably described by Prof. Schulze, from whose memoir the annexed woodcut (Fig. 3) is taken. The membranous wall—very delicate and thin—which surrounds the skeleton is furnished with smooth-edged roundish *pores* of different sizes, irregularly arranged, and varying very much in number. These form an open communication between the cavities of the chambers and the duct-like spaces surrounding them, which penetrate everywhere between the ciliated chambers and extend even to their mouths, where they terminate on a tougher membrane, which binds together and connects laterally the chamber walls. The figure shows the outer portion of a thin section taken perpendicularly to the outer surface through the side wall of a ridge, and is magnified × 150. Several of the ciliated chambers are seen.

Although the Rhizopods are described as standing "first in the scale of animal organisation," we find them treated of in a chapter before that relating to the Infusoria, and we are told in the same paragraph that "they have in a great degree the same simple constitution as several other kinds of animalcules which are grouped by naturalists as Protozoa." We venture to think that such a description will be apt to lead the general reader astray; nor was it quite fair of the Editor to allow the writer of the article on the Rhizopods to go somewhat out of his way in his forty-ninth paragraph to give a view of the organisation of the Sponges which will be apt to puzzle the reader who has perused the more accurate account of the sponge structure given by Prof. Sollas.

As an example of the beautiful illustrations of the Infusoria, which are for the most part taken from Saville Kent's excellently illustrated Manual of Infusoria, we give the woodcut of *Rhipidodendron splendidum*. There are few workers with the microscope who devote themselves to the study of the Infusoria but must be familiar with the stems of that group of animalcules, which gravitate about the well known *Anthophysa vegetans* of Müller; the attached colony stocks putting one in mind of some minute fucoid stem. Of this group the species figured after Stein is one of the most remarkable, originally described and most beautifully illustrated in Prof. Stein's great work. This freshwater form has apparently not yet been found in this country, but a nearly allied species, *R. Huxleyi*, has been met with in South Devon. The figure shows the compound colony stock at A, the quite young colony stock at B, which latter was built up by a single monad, which divided by longitudinal fission, producing two parallel, or nearly so, tubes, and one of these monads is seen at C free, without a tube.

In congratulating the Editor on the successful termination of his labours, we are not unmindful of the difficulties he has had to encounter in trying to secure a more or less uniform style of treatment of subjects so varied as the different classes and sub-divisions of the animal kingdom.

THE CONDENSATION OF LIQUID FILMS ON WETTED SOLIDS

IN *Poggendorff's Annalen* for 1877, and in the *Philosophical Magazine* for 1880, I have recorded some facts which are satisfactorily explicable only on the supposition that the liquid in contact with the glass undergoes condensation upon the surface of the latter. In the latter paper I was able to show that this condensed film visibly altered the resistance experienced by the liquid in flowing through the tube. In the paper in the *Poggendorff's Annalen* it was shown that a difference of potential was set up between the two ends of a capillary tube through which water was forced, and that the effect of leaving the water in contact with the tube was that this difference of potential rapidly diminished. No doubt this finds its explanation in the effect of the condensation of the liquid on the sides of the capillary tube, causing the friction of the water against the tube to become less and less, whilst the friction of the water upon the condensed water-film becomes progressively greater, as the latter adheres more strongly to the glass. Probably simple drying would suffice to restore to the tube the originally observed difference of potential between its ends.

Whilst working upon this subject I noticed the large E.M.F. produced by a small air-bubble slowly ascending through the vertical capillary tube which was full of water (see Dr. Dorn, *Ann. d. Phys. u. Chem.* 1880, S. 73). At the time I could not account for this, but not long ago I constructed an apparatus which allowed of alternate drops of water and bubbles of air being driven through the capillary tube. This produced a very large E.M.F. Probably this increase in the E.M.F. is dependent upon (a) the increased electrical resistance consequent upon breaking up the water in the tube into drops separated by air-bubbles, and (β) upon an increased disturbance of the liquid film adhering to the glass. Experimentally these effects, (a) and (β), might be separated by substituting for water a (practically) perfectly insulating liquid.

Another and very interesting illustration of a liquid condensed on the surface of a solid is probably to be seen in the familiar fact that water will not clean a greasy sheet of glass.

As is well known to all workers on surface tension, almost the only way of getting a *physically* clean surface of glass is by heating the glass in concentrated sulphuric acid, to which a little nitric acid has been added, and then heating, after washing in pure water to remove the acid. Such a glass surface exposed to the air for a short time is generally imperfectly